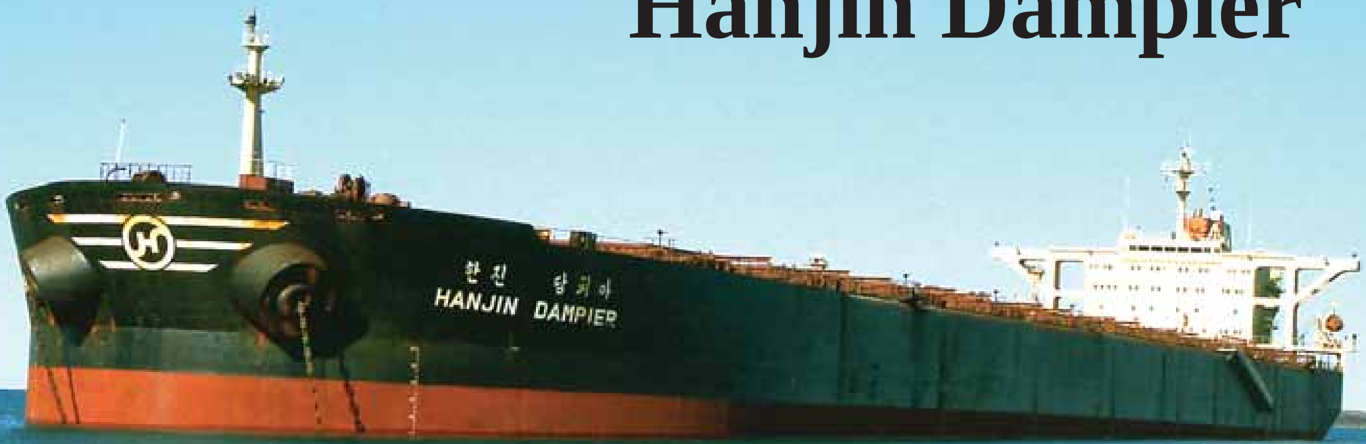
Australian Government
Australian Transport Safety Bureau

Safe Transport

MARINE SAFETY INVESTIGATION
REPORT 184

Independent investigation into the grounding of the
Korean flag bulk carrier

Hanjin Dampier



at Dampier, Western Australia
25 August 2002

Australian Government

Australian Transport Safety Bureau

Navigation Act 1912
Navigation (Marine Casualty) Regulations
investigation into the grounding of the Korean flag bulk carrier
Hanjin Dampier
at Dampier in Western Australia
on 25 August 2002

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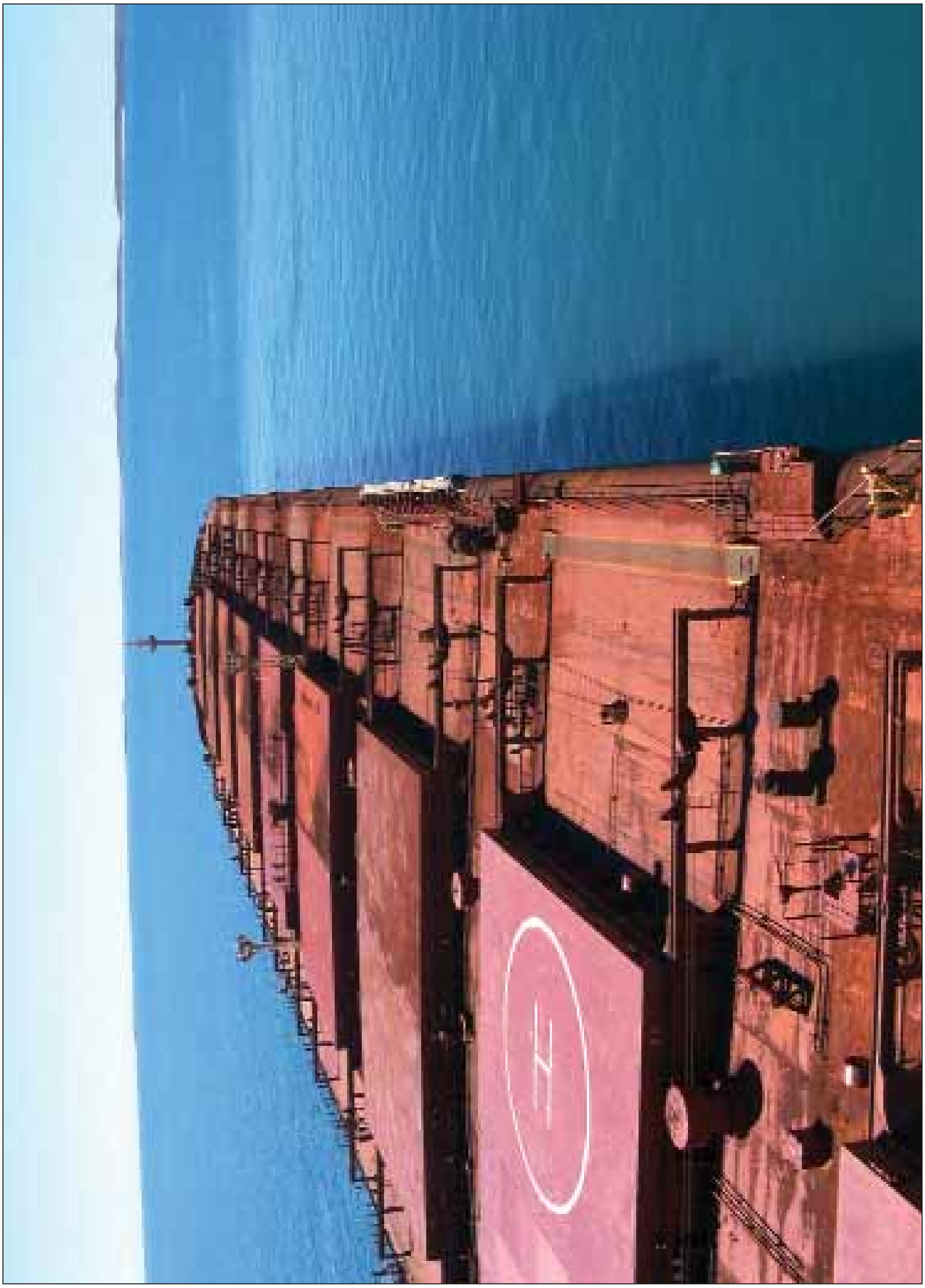
Hanjin Dampier



Summary

At 1032 on 25 August 2002, the Korean flag bulk carrier *Hanjin Dampier* departed from the Hamersley Iron wharf at East Intercourse Island in the port of Dampier, Western Australia. A pilot was conducting the navigation of the ship which was loaded with iron ore and had a displacement of 233 158 tonnes with draughts of 17.94 m forward and 18.10 m aft.

At 1127, just after *Hanjin Dampier* passed number four Hamersley Channel beacons, two of the ship's three main generators stopped, leaving only one generator running and connected to the main switchboard.

At 1152, with the ship 1.3 miles east of Courtenay Head and making headway at a little over eight knots, the third generator's circuit breaker tripped open. With the total loss of power to the main switchboard the main engine stopped and the ship lost steering. The rudder had stopped at 10° to starboard. As the ship slowed, it started to turn to starboard towards shallow water. The emergency generator failed to start automatically and, as a result, steering was not restored for some four minutes.

At 1202, *Hanjin Dampier* touched bottom. By about 1203 the ship had come to a stop on a heading of 047°(T) in a position between the charted deep draught track and the Woodside Channel (20° 29.7'S, 116° 43.3'E).

Hanjin Dampier was refloated on the next spring tide, on 8 September, using five tugs and after 5000–6000 tonnes of cargo had been discharged. The ship had suffered only minor damage to the bottom shell plating and the ship was cleared by the classification society to continue trading until the next scheduled dry-docking.

The report's conclusions include:

- The ship grounded as a direct result of the loss of steering;
- Steering was lost when the ship's three main generators tripped off the main switchboard due to water contamination of their fuel supply;
- The emergency generator failed to start automatically due to a fault in one of its starting batteries;
- The crew took no action nor instigated any contingency plan in the time leading up to the blackout when they could have reduced the risk to the ship; and
- Lack of effective communication between the chief engineer and master contributed to the crew's failure to take any pre-emptive action.

The report makes three recommendations involving the testing of emergency power arrangements, bridge resource management training for engineers and the use of tugs in the port of Dampier.

Sources of Information

Officers and crew of *Hanjin Dampier*

The pilot

Hamersley Iron Pty. Limited

Dampier Port Authority

The Australian Maritime Safety Authority

References

International Convention for the Safety of Life at Sea, 1974, and its Protocol of 1988 (SOLAS), the International Maritime Organization.

The International Management Code for the Safe Operation of Ships and for Pollution Prevention [International Safety Management (ISM Code)] as adopted by the International Maritime Organization by resolution A.741(18).

International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention), 1978, and 1995 amendments, and the STCW Code, the International Maritime Organization.

Bridge Procedures Guide, the International Chamber of Shipping.

Australian Pilot Volume V, (North, North-West and West Coasts of Australia from the West Entrance of Endeavour Strait to Cape Leeuwin), Seventh Edition 1992, Admiralty Charts and Publications.

Narrative

Hanjin Dampier

Hanjin Dampier, (figure 1), is a Korean flag, capesize, bulk carrier of 207 346 deadweight tonnes at its summer draught of 18.02 m. The ship is owned and managed by Hanjin Shipping Company of Seoul in South Korea. It is classed with the Korean Register of Shipping, as +KRS 1[1] Bulk Carrier ESP[2] with +KRM 1[3] and UMA[4] notations.

Hanjin Dampier was built in 1989 by Hyundai Heavy Industries at Ulsan, in Korea. The ship has nine holds forward of the accommodation superstructure, an overall length of 309.00 m, a beam of 50.00 m and a depth of 25.70 m. Propulsive power is provided by a Hyundai B&W 6L80MCE slow speed, single acting, direct reversing diesel engine of 12 959 kW which drives a single fixed-pitch propeller to give the vessel a service speed of 13 knots.

Hanjin Dampier is engaged primarily in the iron ore trade between Western Australian and South Korean ports. The ship is a regular caller at Dampier and Port Hedland.

At the time of the incident, *Hanjin Dampier* had a crew of 22 comprised of; the master and three mates, a trainee deck officer, the chief and three engineers, a trainee engineer, two chief ratings, eight other ratings and two cooks. The mates maintained a traditional 'four on, eight off' watchkeeping routine at sea. The engineers worked a 24 hour duty roster with the engine room unmanned outside normal working hours. The crew were either Korean or Indonesian nationals.

The master of *Hanjin Dampier* held a Master class 1 certificate of competency issued in Korea and had 27 years experience at sea, the last nine of which were in command. The chief engineer had a combined (motor and steam) Chief Engineer's certificate of competency issued in Korea, had 30 years experience at sea the last 12 of which were as chief engineer. He had joined the vessel for the first time on 3 August, three weeks before the incident.

Dampier

The port of Dampier, (figure 2), is located on the north-west coast of Australia on the south western side of the Burrup Peninsula. It is a major export port for primary products including iron ore, liquefied natural gas, and salt. The port is also the main operational base for offshore contractors working on the North West Shelf natural gas project.

Ships approach Dampier from the north and must transit one of two shipping channels in Mermaid Sound, the body of water between the Burrup Peninsula and the islands of the Dampier Archipelago. The Woodside Channel is on the east and the Hamersley Channel on the west of the Sound. The Woodside Channel extends from the top of Mermaid Sound south to the Woodside natural gas facility just south of Withnell Bay. The Hamersley Channel starts halfway down Mermaid Sound and extends approximately five miles to the south until it divides into two inner channels both approximately 2.5 miles in length. The western inner channel terminates at the Hamersley Iron ore loader on East Intercourse Island and the eastern inner channel extends to the Hamersley Iron ore loader at Parker Point.

The Hamersley inner channels have a maintained depth of 15.5 m (below Lowest

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1 Hull built under Korean Register survey.

2 Enhanced survey program.

3 Machinery built under Korean Register survey.

4 Unmanned machinery space.

Astronomical Tide) and a maintained depth of 15.6 m in the outer channel. A series of navigation beacons mark the channel from the berths at East Intercourse Island and Parker Point to the fairway beacon located in the middle of Mermaid Sound. From the fairway beacon, outbound loaded vessels, constrained by their draught, follow a recommended deep draught track for a further seven miles until they clear the relatively shallow water at the northern end of the Sound. This track is marked by navigational buoys and finishes at the Sea Buoy at the northern end of Mermaid Sound.

Iron ore ships entering and leaving Mermaid Sound must carry a pilot supplied by a company contracted exclusively to Hamersley Iron. The pilots board and disembark these vessels, using helicopters, at a position between the Sea Buoy and the outer anchorage to the north-west. Tug services for iron ore ships are provided by Hamersley Iron, who operate four harbour tugs.

The mean high water level in the port during spring tides is 4.4 m, with 3.1 m for neap high tides. Ships loading at Hamersley Iron ore terminals are almost exclusively capesized bulk carriers most in the range of 150 000 to 250 000 deadweight tonnes. The predicted high water levels within the port at various times through the year and minimum under keel clearance requirements govern the size of the vessels chartered. Vessels with smaller maximum draughts are chartered for neap tides and larger vessels may be used for spring tides so that every vessel is loaded as closely as possible to its maximum draught.

Loaded iron ore vessels depart in tidal windows calculated by Hamersley Iron using a dynamic under keel clearance (DUKC) system. The system generates a plan for the passage from the iron ore berth to the Sea Buoy, based on the vessel's draught and stability parameters, a hydrographic model of the passage and accurately predicted tidal heights and sea conditions. The plan contains several different timings at selected waypoints in the passage depending on the speed of the transit and the departure time within the tidal window. The height of the tide, the ship's bottom clearance and manoeuvrability margin are calculated for each waypoint at the different times specified in the plan. Departure draughts vary from about 14.5 m to 18.5 m, with transit times from the berth to the Sea Buoy varying between about 120 and 150 minutes.

The incident

At 1032 on 25 August 2002, *Hanjin Dampier* departed from the Hamersley Iron wharf at East Intercourse Island. The ship was bound for the port of Kwangyang in South Korea. A pilot was conducting the navigation of the ship which was loaded with iron ore and was displacing 233 158 tonnes with draughts of 17.94 m forward and 18.10 m aft. On the bridge with the pilot were the master, third mate and a helmsman. The weather was fine with a light southerly breeze. High water at King Bay was predicted to be 4.37 m at approximately 1213.

The chief, first, second and third engineers were all in the engine control room for the departure. The third engineer was the duty engineer for the day and had completed the engine room warm-through procedures prior to the 'stand-by'. Numbers one and three main generators were running in parallel connected to the main switchboard to supply the ship's electrical power. The generators were both running on marine diesel oil supplied from the diesel service tank. Number two main generator was selected as the stand-by generator.

Prior to the departure 'stand-by', starting at about 0930, the second engineer had transferred some diesel from the double bottom storage tanks to the diesel settling tank. He had had difficulty getting suction on the starboard storage tank, which was almost empty, and so had changed over the transfer pump suction to the port storage tank which had not been used for some time. When the diesel settling tank had started to fill satisfactorily, the second engineer started the diesel purifier in order to top up the diesel service tank.

By 1039 *Hanjin Dampier* was safely off the berth and the pilot had released the two tugs, *Star* and *Saturn*, which had assisted the ship unberthing. The ship then proceeded down the Hamersley Channel with the pilot progressively increasing the ship's speed until 'full ahead' was rung at 1052.

At 1123 the pilot slowed the main engine to 'half ahead' as the ship was getting ahead of the schedule in the passage plan generated by Hamersley Iron's DUKC program.

At 1127, just after *Hanjin Dampier* passed number four Hamersley Channel beacons, 'Main Switchboard Abnormal' and 'Bus Frequency Low' alarms sounded in the engine control room. In the next two minutes a number of things occurred:

- the main switchboard power management system started number two generator;
- number one generator circuit breaker tripped open;
- the first preference trips on the main switchboard opened isolating power to some of the ship's non-essential services;
- number two generator circuit breaker closed after it had been automatically synchronised;
- number two generator circuit breaker tripped open again;
- the second preference trips on the main switchboard opened.

At this point, number one and two main generators stopped, leaving only the number three generator running and connected to the main switchboard and carrying a load of approximately 400 kW.

The chief engineer did not know why the generators had stopped and, together with the other engineers, started to investigate. It was around this time he rang the master on the bridge and said words to the effect:

> We need to check the generators and make repairs after we clear the channel…

The chief engineer knew that they were in a narrow channel but he did not tell the master that two of the main generators had already shut down.

The master did not speak to the pilot regarding the conversation with the chief engineer. At this point in the passage the pilot was not aware that there was any problem in the engine room and so, at 1136, he increased the main engine speed again to 'full ahead'.

At first, the chief engineer checked the generator circuit breakers while the other engineers checked the generators. The second engineer attempted to start the generators locally several times but was unsuccessful. After finding no problem with the circuit breakers, the chief engineer also started checking the generators, including the overspeed shutdowns which he found had not tripped. During this time the engineers reinstated the ship's non-essential services which had stopped when the switchboard preferences tripped.

Hanjin Dampier passed the fairway beacon at the entrance to the Hamersley Channel at 1143. After clearing the channel, the pilot ordered the helmsman to steer a course of 019° (T) to bring the ship onto the recommended deep draught track. The ship's speed at this time was approximately eight knots.

At 1151 number three main generator started to slow down causing another 'Bus Freq. Low' alarm. Approximately one minute later, at 1152, number three generator circuit breaker opened and the ship blacked out. The generator continued to run.

With the total loss of power to the main switchboard, all of the electrically-driven pumps for the main engine stopped, resulting in a main engine shut down. The electrically driven pumps on the steering gear also stopped and the ship lost steering. At this point the ship was 1.3 miles east of Courtenay Head, just south of the number four buoys marking the deep draught track, and making headway at a little over eight knots.

When the ship blacked out the pilot contacted Dampier port communications to inform them of the situation. He also made contact with the tugs *Saturn* and *Comet* requesting that they attend the vessel.

During this time the master had sounded the ship's alarm and broadcast an order to 'stand-by all stations' over the public address system. He told the mate take a party forward to stand-by to let go the anchors.

The chief engineer in the control room could see that the emergency generator had failed to start (the emergency generator 'run' light on the main switchboard did not illuminate). He sent the first engineer up to the emergency generator room on the main deck to investigate.

At 1153, when it became apparent that number three generator was still running, the chief engineer closed its circuit breaker. Power to the main switchboard was restored for a brief period with various equipment starting automatically including number two steering pump motor. However, as the electrical load increased, number three generator started to slow down again until its circuit breaker tripped leaving the switchboard dead once more. Number two steering pump motor stopped at this time leaving the rudder 10° to starboard.

When the first engineer arrived in the emergency generator room he could hear the generator's starting solenoid clicking, but could see the starting battery voltmeter showing a low voltage. He realised that he would have to use the generator's secondary hydraulic starting system to try to start the generator and so started to pump up the hydraulic starting accumulator, using the hand pump in the system.

The mate, boatswain and two seaman, after hurrying up the main deck, arrived on the forecastle, where they prepared to let go the ship's anchors at the master's command.

At approximately 1155, *Hanjin Dampier* passed number four buoys. With 10° of starboard rudder the ship was starting to turn to starboard towards the shallow water on the eastern side of the deep draught track. The pilot contacted the tugs at this time to request that a third tug attend the ship.

At approximately 1156 the first engineer managed to start the emergency generator and close its breaker on the emergency switchboard. Number one steering pump motor, supplied from the emergency board, started automatically. Shortly after this, the rudder was put hard to port but the ship continued to turn to starboard.

During this time the master and pilot discussed the option of letting go the anchors to try to slow the ship. The pilot advised the master not to let go the anchors as he felt that with the ship's momentum and limited under keel clearance, it would be dangerous and imprudent to do so. The master concurred and made the decision not to let go the anchors.

At 1200, Hamersley Iron marine operations base contacted the pilot to indicate that the third tug was on its way and would be at the ship as soon as possible.

At 1201 the ship was still making headway at about six knots.

At 1202, *Hanjin Dampier* touched bottom. The master and pilot did not feel anything untoward in the ship's motion but saw clouds of mud being stirred up with the ship slowing noticeably. By about 1203 the ship had come to a stop on a heading of 047°(T) and had taken a slight list to port of 2.5°. The ship was aground in a position 3.5 cables north-north-east of the number four buoys (20° 29.7'S, 116° 43.3'E) between the deep draught track and the Woodside Channel.

At 1204, the pilot talked again to Hamersley Iron base to indicate that the ship was definitely aground and that he would like four tugs.

After the ship had grounded, the master instructed the crew to sound all double bottom tanks to see if the ship's hull had been holed. They reported back some time later to indicate that all the double bottom tanks appeared to be intact.

At around this time, one of the engineers checked the diesel service and settling tank drains and found that the fuel running from the drains appeared to be emulsified. Further investigation revealed that the fuel in the main generator supply lines was also emulsified, apparently contaminated with water. The engineers set about draining the contaminated fuel from the settling and service tanks and generator fuel lines.

At 1208, the pilot spoke to Dampier port communications to indicate that the ship appeared to be undamaged and that there was no sign of any oil spillage.

The tugs *Saturn* and *Comet* arrived alongside *Hanjin Dampier* at about 1230.

By 1231, the engineers had managed to start number three generator and close its circuit breaker to power the main switchboard. Once electrical power had been restored the engineers set about resetting the various engine room systems and preparing the main engine for manoeuvring. Number two generator was running and connected to the switchboard by 1242 and the main engine prepared to start by 1245.

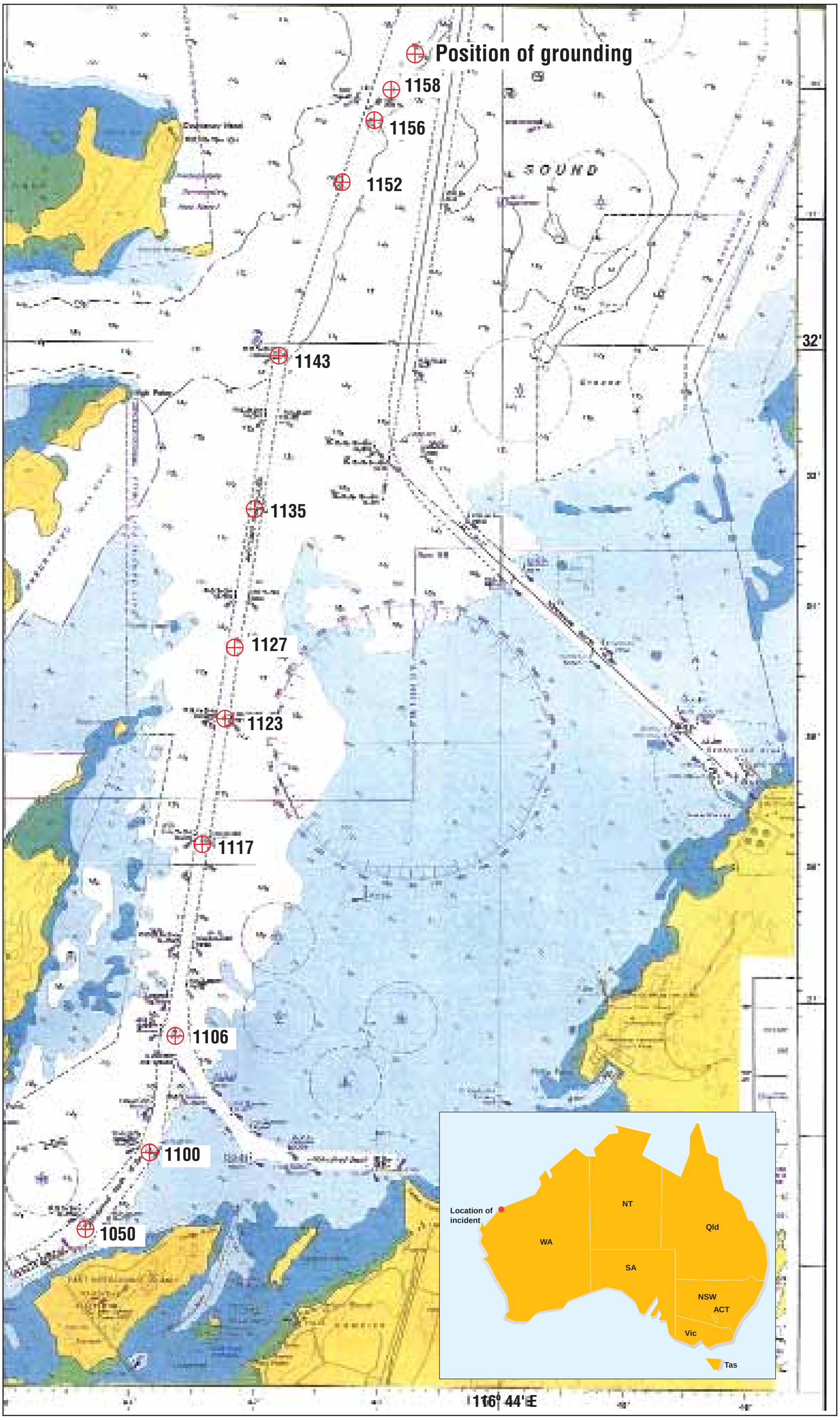
A third tug, *Star*, had arrived at the ship and, by 1246, was made fast at the ship's bow. The tugs *Saturn* and *Comet* were made fast on either quarter at the stern of the ship. A fourth tug, *Mars*,was en route to the ship by this time.

Between 1250 and 1310 two attempts were made to move *Hanjin Dampier* into the deeper water astern of the ship using the three tugs in various positions and the ship's main engine. These attempts failed.

By 1345 the fourth tug had arrived together with the offshore supply vessel *Massive Tide* and a third attempt to move the ship was made using all of the towing vessels and the main engine. This attempt also failed with the ship's line securing *Massive Tid*e parting in the process. In view of the falling tide, attempts to refloat the ship were abandoned at this time.

Hanjin Dampier was finally refloated on the next spring tide, on 8 September, using five tugs and after 5000–6000 tonnes of cargo had been discharged. The ship had suffered only minor damage to the bottom shell plating and was cleared by the classification society to continue trading until the next scheduled dry-docking.

FIGURE 2:
Chart showing approximate track of *Hanjin Dampier*



Comment and analysis

Evidence

On 27 August 2002, a marine investigator from the Australian Transport Safety Bureau attended *Hanjin Dampier*, aground, in the port of Dampier. The master and chief engineer were interviewed and provided accounts of the incident. Copies of relevant documents were obtained including: logs, alarm print outs, written statements, fuel records, various procedures and maintenance instructions. Fuel samples were taken from the tanks within the diesel supply system for chemical analysis.

The pilot was interviewed on 29 August and also provided a detailed account of the incident.

Dampier Port Authority provided recordings of the port's working VHF radio channels around the time of the incident.

An events and causal factors chart for the incident is reproduced in figure 3.

The incident

On 25 August 2002, *Hanjin Dampier* grounded as a result of the total failure of the ship's electrical power supply and the lack of timely intervention by the crew, when the risk to the ship could have been mitigated. The initial shut down of number one main generator occurred at 1127; a minute later number two main generator also stopped to leave only number three generator supplying all of the ship's electrical power. At this point in the passage, there was time (although limited by the tidal window), to stop the ship, either in the channel or after it had cleared the channel, and investigate the generator shut downs.

When he rang the bridge after the initial shut down of the two generators, the chief engineer indicated to the master that there were some problems with the generators. He did not tell the master the nature of the problem, nor did they discuss any contingency plan. The master in turn did not tell the pilot of the generator problems and so the pilot was unaware that the passage was anything other than 'normal'. When he ordered 'full ahead' at 1136, 16 minutes before the blackout, the pilot unknowingly increased the risk to the ship by increasing its speed.

When he spoke to the master the chief engineer did not know what had caused the generators to shut down. He was aware that the ship was restricted in its ability to manoeuvre due to its minimal bottom clearance and his words to the master were that he would need to check the generators after the ship cleared the 'channel'. The master took this to mean that the work would need to be done once the ship was in deeper water clear of the Sea Buoy. It is unclear whether there was some confusion at this point, however there was another opportunity to stop in slightly deeper water and rectify the generator problem when the ship had cleared the Hamersley Channel at 1143.

When the main switchboard blacked out, at approximately 1152, the ship lost electrical power both to the main engine pumps and the steering gear. The emergency generator should have come on-line and steering should have been restored approximately 30 seconds after the initial blackout. However, the emergency generator failed to start automatically and had to be manually started by one of the engineers. With 10° of starboard rudder, the ship had already started turning to starboard, towards the relatively shallow water east of the deep draught track, when steering was restored at approximately 1156.

Both the master and the pilot indicated that they thought that steering was restored at about a minute before the ship grounded at 1202. This is at odds with the engine room alarm logger which recorded normal voltage to number one steering gear motor and an overload alarm to indicate that number one steering pump motor, supplied by the emergency generator, had started at 1156. At this point steering would have been available. It is unclear whether or not the bridge team realised that steering was available in the period between 1156 and approximately 1201 or, in fact, if their recollection of the timing of the events was incorrect. It is a matter for some conjecture whether port rudder, applied as soon as steering became available at 1156 (as opposed to 1201), would have arrested the turn to starboard. With the main engine stopped, the effect of the rudder would have decreased as the ship slowed even though its speed was still just above the minimum steering speed of 4.3 knots. In any event, given the ship's position at 1156, its likely course with the rudder hard to port and the extent of the shoal water ahead, it is unlikely that the grounding could have been avoided at this point.

The decision not use the ship's anchors was probably prudent considering the ship's very limited bottom clearance and momentum. After steering was lost, the ship started to turn to starboard out of the channel, with its bottom clearance decreasing until it grounded. With a maximum draught of 18.10 m the ship had less than a metre bottom clearance as it passed number four buoys. Given the size of the anchors, it is probable that the ship would have sustained severe bottom damage as it rode over the top of the anchors if they had been let go. In addition, with a displacement of 233 158 tonnes and headway of six knots or more, the effectiveness of the anchors would have been very limited with a very high likelihood of cable/windlass damage if they had been used.

There was a succession of events which led to the grounding, in essence these were:

- the contamination of the generator fuel supply which led to the blackout, loss of propulsive power and loss of steering
- the failure of the emergency generator to start automatically which meant that the ship was without steering for a critical period with the rudder stopped at 10° to starboard
- the failure of the crew to correctly assess the situation and take appropriate action during the 25 minute period between the first generator shut down and the blackout at 1152.

The initial generator shut downs

The shut down of the main generators was the result of the fuel contamination later found by the engineers. The 'bus low frequency alarms', recorded before each of the main generators tripped off the switchboard, indicated that the diesel prime movers were slowing down in a manner which is consistent with contamination of their fuel supply. Unfortunately the engineers did not retain a sample of the contaminated fuel which they drained from the generator fuel supply system, so the actual level of fuel contamination which led to the generator shut downs could not be determined.

Fuel analysis

Samples of fuel were taken from the diesel service, settling and storage tanks, port and starboard, and diesel transfer pump suction filter on 27 August, two days after the incident. The samples were tested for water content, the presence of sodium chloride (salt) and bacterial contamination, by Intertek Testing Services (Australia). The tests yielded the following results:

Sample Origin	*Water content (percent wt)*	*Salt*	*Viable Bacteria Count (#/ml)*
Diesel Storage Tank Port	0.60	Yes	Less than 100
Diesel Storage Tank Starboard	0.05	No	Less than 100
Diesel Settling Tank	0.70	Yes	200
Diesel Service Tank	0.90	Yes	Less than 100
Diesel Transfer Pump Suction Filter	Trace only	No	16000

Based on the test results it is likely that the generator fuel was contaminated with salt water originating from the port diesel storage tank. The increasing water percentages in the settling and service tanks is consistent with progressive dilution of the contaminant as additional fuel of lower water content was transferred from the port storage tank in the two days between the incident and sampling. The water content of the service tank sample, at 0.9 percent, is high and indicates that purification was not effective.

The level of bacterial contamination does not appear to be significant for any of the tanks. The sample from the diesel transfer pump suction filter has a bacteria count which is significantly higher than the storage tanks from which it regularly draws. The likely cause of this apparent aberration is sample contamination.

Source of the contamination

The ship's records indicate that, on 27 June 2002, 160 tonnes of diesel was loaded from a barge in Kwangyang, Korea. This was the last time prior to the incident that diesel had been bunkered into the port storage tank. The loading plan indicates that the first 60 tonnes was bunkered into the empty port storage tank and then the balance was bunkered into the starboard storage tank. The fuel delivery docket states that the diesel fuel had a water content of 0.05 per cent. The sample taken from the starboard storage tank on 27 August had a water content of 0.05 per cent which supports the validity of the information provided by the fuel merchant on the delivery docket.

No diesel had been transferred from the port storage tank between bunkering on 27 June and the day of the incident. Allowing that the bunker records regarding water content are accurate, seawater must have entered the tank in the eight weeks or so since bunkering. The ship's tank sounding records were inconclusive, although there appears to have been an increase in the level in the tank of four centimetres between 27 June and 31 July. Inspection after the incident revealed that both storage tank manhole covers were in place with their bolts intact. However when the port storage tank manhole cover was removed, its gasket was found to be broken and unserviceable. The evaporator drain line is in the vicinity of the port storage tank manhole. It appears likely that the water in the port storage tank originated from the drain line and gained access to the tank via the broken gasket.

The diesel purifier

On the morning of the incident, the second engineer had checked both the service and settling tank drains and found no trace of water. Later in the morning he transferred diesel from the port storage tank to the diesel settling tank and then started the diesel purifier to top up the diesel service tank. It was during this time that the water in the generator fuel was passed from the settling tank to the service tank. For the water to have been carried over into the service tank, the purifier must have been operating incorrectly.

Purifiers are designed to separate materials or liquids of higher density from the process liquid using centrifugal force. In the case of a diesel purifier, the process liquid is diesel and the 'heavy phase' is any water or solid particles in the diesel with a density higher than that of the diesel. Unpurified diesel is introduced into the purifier 'bowl', shaped like two cones joined at their bases, which is spinning at very high speed. Inside the bowl, the diesel is subjected to very large centrifugal forces which 'spin' the higher density water and solids to the outside of the bowl where they are collected. The water is then discharged continuously through the heavy phase outlet (water outlet), with both water and solids being periodically discharged from the periphery of the bowl when it is opened (de-sludged). The 'clean' diesel is discharged continuously through the 'light phase' outlet. Some water is present at the periphery of the purifier bowl at all times to seal it. The point where the water and the diesel meet at the periphery of the bowl is called the 'interface'.

For efficient separation of any water from the diesel, it is essential to establish the interface between the two phases in the correct position within the purifier bowl. This is achieved by controlling the 'back pressure' on the water outlet using a dam ring (gravity disc) of the correct size for the density of the diesel being purified. The position of the interface is also governed to a lesser extent by the purified diesel outlet back pressure which is manually controlled using a throttling valve in the outlet line. If the gravity disc is too large and/or the outlet line back pressure is too high, the interface will be too close to the periphery of the bowl and fuel will be carried over into the water outlet. Conversely, if the gravity disc is too small and/or back pressure is too low, the interface will be too close to the centre of the bowl and purification will be inefficient, with water being carried over in the purified fuel.

At the time of the incident, *Hanjin Dampier*'s diesel purifier was fitted with a 63 mm gravity disc. The manufacturers suggest that when purifying diesel in that particular model of purifier, a gravity disc of 68 mm or larger should be used. When running after the incident, the purifier was found to have a fuel outlet line back pressure of 0.5 kg/cm^2. This is less than usual, with a normal back pressure being between 0.8 and 1.2 kg/cm^2. The likely effect of the small gravity disc and low outlet line back pressure was to move the interface towards the centre of the bowl until a proportion of the water in the diesel from the settling tank was carried over into the fuel outlet. It is likely that it was the combination of these two factors which allowed the water to be passed from the diesel settling tank to the diesel service tank and, from there, to the main generators.

The emergency generator

When the first engineer arrived in the emergency generator flat after the blackout at 1152, he quickly ascertained that there was fault with the generator's electric starting system. He then set about using the secondary hydraulic starting system to start the generator. In all, it took approximately four minutes for the emergency generator to be started and connected to the emergency switchboard.

In normal circumstances the loss of voltage on the main switchboard busbars initiates the emergency generator automatic start sequence which restores power to the emergency switchboard in less than 30 seconds (SOLAS[5] requires a maximum of 45 seconds). The motor on number one steering pump is supplied from the emergency switchboard and would have started as soon as the emergency generator came on line restoring the steering very quickly after the blackout. Had this occurred on 25 August, it is likely that *Hanjin Dampier* could have been kept within the channel as it lost headway and the grounding could have been avoided.

Investigations after the incident revealed that one of the emergency generator's two starting batteries (the 24 V starting system is supplied by two 12 V batteries connected in series) was faulty. Electrolyte levels within the batteries were satisfactory and so was the 'float' voltage displayed on the battery charger. However subsequent load testing revealed that a cell within one of the batteries had failed. The batteries had been replaced in March 1999 and were not scheduled for renewal until March 2004.

The ship's records indicated that the emergency generator was tested, on average, once a month with the last time being on 13 August, 12 days before the incident. Each time the emergency generator was tested, the engineer performing the work completed a checklist. The checklist prescribes a number of checks, including the battery float voltage, followed by a running test of the generator. There is provision on the checklist to record the test results and any other observations. There were no abnormalities recorded on the checklists completed by the

5 The International Maritime Organization's, International Convention for the Safety of Life at Sea, 1974, and its Protocol of 1988 (SOLAS).

engineers who had performed the previous four tests, and nothing to indicate any problems with the starting battery.

Although it is common practice on many ships, like *Hanjin Dampier*, to test the emergency generator only once per month, there are also many ships where it is tested as frequently as every week. Had the generator been tested in the week prior to the incident, it is possible that the problem with the starting battery may have been discovered and rectified.

SOLAS Regulation 43, 'Emergency source of electrical power in cargo ships', section 7, states:

> Provision shall be made for the periodic testing of the complete emergency system and shall include the testing of automatic starting arrangements.

As such, SOLAS requires that emergency power systems are only tested 'periodically', with no specific test interval stipulated. SOLAS does, however, stipulate testing intervals for other critical safety equipment like lifeboat engines, which must be tested weekly. It seems inconsistent that emergency generators should rate operation and inspection as infrequently as once every month.

Contingency plans

Numbers one and two generators tripped off the main switchboard, and stopped, at about 1128. At the time the ship was still in the Hamersley Channel, with an estimated time of arrival at the Sea Buoy of 1245, more than an hour and a quarter later. With no back-up main power supply and a very limited ability to manoeuvre, the ship's safety was at risk. Given his uncertainty regarding what had caused the generator shut downs, and his awareness of the ship's critical navigation situation, the chief engineer should have discussed the situation more fully with the master. This would have given the master the opportunity to form a contingency plan, in consultation with the pilot, to mitigate the risk to the ship. There was adequate time at this point in the passage, (number three generator continued to supply power for a further 24 minutes), to stop the ship either in the channel or after it had cleared the channel in deeper water and to call for tug assistance. In the event, the chief engineer did not communicate the gravity of the generator problem to the master and this failure of communication directly contributed to the grounding.

Bridge Resource Management

The International Maritime Organization's Seafarers' Training, Certification and Watchkeeping Code (STCW Code), Section B-VIII/2 'Guidance regarding watchkeeping arrangements and principles to be observed' contains operational guidance which should be taken into account by companies, masters and watchkeeping officers.

Part 3-1-4 under the heading 'Bridge Resource Management' sets out a number of principles regarding the way bridge resources and members of the bridge team are to be managed during a navigation watch. The section also refers specifically to the International Chamber of Shipping's 'Bridge Procedures Guide'. Both the STCW Code and the Bridge Procedures Guide place emphasis on the need for bridge personnel to work as a team and to communicate effectively, particularly at times when the ship is navigating in confined waters. In his submission the pilot stated that he was happy with the performance of *Hanjin Dampier*'s bridge team during the pilotage on the morning of 25 August.

Neither the STCW Code nor the Bridge Procedures Guide, however, contain any guidance relating specifically to establishing effective communication between deck and engine room watchkeeping staff. In critical ship's operations, like pilotage, there is a need to ensure that communication is effective between the bridge and the engine room. The engineers are a critical part of the ship's 'team' and should take an active role at these times.

Many maritime administrations around the world require deck officers to complete bridge resource management training as part of their certificates of competency. There are no comparable requirements for engineering officers who are not generally offered this type of training. On 25 August, had there been more effective communication between the chief engineer and master at the critical time after the first two generators had shut down, it is likely that the grounding of *Hanjin Dampier* could have been averted.

Shipboard safety management system

Hanjin Dampier had a current Document of Compliance and Safety Management Certificate issued by the Korean Register of Shipping. As such, the vessel was found to be in compliance with the provisions of the ISM Code in respect of its safety management system.

The ISM Code applies to all ships and states under '1.2 Objectives':

> 1.2.1 The objectives of the Code are to ensure safety at sea, prevention of human injury or loss of life, and avoidance of damage to the environment, in particular to the marine environment and to property.
>
> 1.2.2 Safety-management objectives of the Company should, inter alia:
>
> .1 provide for safe practices in ship operation and a safe working environment;
>
> .2 establish safeguards against all identified risks…

Hanjin Dampier's safety management system included procedures, in the form of emergency checklists for the bridge and engine room, for main engine breakdown and generator blackout. The checklists were of a general form and did not relate specifically to the vessel or a pilotage situation. As such, the checklists would not have provided any guidance or advice which would have been of assistance to the master or chief engineer during the events which occurred on 25 August.

The ship's safety management system also provided periodic training for various emergency situations including a generator failure and blackout. The ship's records indicate that this scenario had last been practiced on 2 November 2001, more than ten months prior to the incident. Given that the usual employment contract on the vessel is six months, it is doubtful that any of the crew on the ship at the time of the incident had taken part in this training exercise. This sort of training, conducted regularly, has the potential to be very beneficial, as it allows the ship's crew to practice their responses to unusual situations and be better prepared to make critical decisions when real emergencies arise.

In summary, the ship's safety management system did not provide any guidance or training which would have assisted *Hanjin Dampier*'s crew in preventing the ship from grounding on 25 August.

Pilotage considerations

Past incidents

Hanjin Dampier is not the first ship to go aground in the port of Dampier. There have been at least three other groundings in the ten years prior to the *Hanjin Dampier* incident including; *Pierre LD* in 1992 (ATSB report number 47), *Bulkazores* in 1995 (ATSB report number 78) and *Asia Angel* in 1998. The *Pierre LD* grounding, in particular, is very similar to the *Hanjin Dampier* incident.

In November 1992, the capesized bulk carrier *Pierre LD* ran aground when leaving Dampier after loading iron ore at East Intercourse Island. Like *Hanjin Dampier*, *Pierre LD* lost steering as a result of a main switchboard blackout just after the ship had cleared the Hamersley Channel. The ship was turning to port at the time, and continued to turn to port after the blackout until it grounded on the eastern side of East Malaus Island.

The passage

Hamersley Iron's DUKC system predicts a ship's bottom clearance and manoeuvrability margin at every stage throughout the passage from the berth to the Sea Buoy. The system bases its calculations on the wave and tide data measured in real time. In terms of safety assurance, the DUKC system represents a significant improvement over static UKC rules which stipulate a fixed minimum under keel clearance based only on the predicted height of tide and surveyed depths. The static system does not have the capacity to revise the passage plan when sea conditions deteriorate or the tide varies from the prediction. On these occasions the DUKC system may provide larger actual under keel clearances than the static rules despite a smaller bottom clearance limit. On most occasions, however, Hamersley Iron ships sail from the port with less bottom clearance (albeit more accurately predicted) using DUKC than was the case when static UKC rules were used to plan the passage. This has led to a substantially increased cargo output for the port.

The DUKC system is predicated upon a 'normal' passage and as such does not allow for adverse events like that which occurred on 25 August 2002. On the day of the incident, *Hanjin Dampier* departed East Intercourse Island close to the earliest possible time in the tidal window predicted for the outbound passage. The early departure would have allowed *Hanjin Dampier* to stop during the pilotage for a limited time to rectify the situation if the crew had elected to use this option. On the day, the generator fuel problem could probably have been rectified in this limited time allowed by the tide. However, if the ship had departed later and/or the generator problem had been more severe, there was insufficient time and no water deep enough to anchor the ship anywhere between the berth and the Sea Buoy. *Hanjin Dampier*, with an average draught of 18.02 m, would have grounded on the next low tide regardless.

Hamersley Iron have considered the risks associated with the pilotage of deep draught ships leaving the port. All the pilots have been trained to deal with a variety of adverse situations and, in addition, Hamersley Iron have recently modelled a limited range of dead ship scenarios on the ship handling simulator at the Australian Maritime College. The scenarios modelled were based on a loaded bulk carrier experiencing a propulsion failure between five and fifteen minutes of leaving the berth at East Intercourse Island. In all the scenarios the ship was successfully towed back to the berth using two or three tugs, or towed out of the channel to the deeper water adjacent to the fairway beacon. In each case the assistance of two tugs was readily at hand and steering failure in addition to the propulsion failure was not modelled. It appears that propulsion/steering failures involving ship's more than fifteen minutes from the berth were not considered in these trials.

Tug assistance

On the morning of 25 August, the pilot on board *Hanjin Dampier* let the tugs go after the ship had cleared the berth at East Intercourse Island. The tugs then stood by to assist with berthing the next bulk carrier, which was to come alongside the East Intercourse Island berth immediately after *Hanjin Dampier* had left. This is the usual practice in the port, with outbound ships making the remainder of the passage to the Sea Buoy unescorted.

Navigating the Hamersley Channel represents the area of greatest risk to outbound deep draught ships. When departing early in the tidal window, ie. on the rising tide, under keel clearance is at a minimum while the ships are transiting the channel. Their manoeuvrability is limited by the width of the channel (approximately 180 m for the outer five miles) with the bottom shelving quite rapidly either side of the channel. An average passage from the berth to the fairway buoy at the entrance to the channel takes around 80 minutes, which is a considerable time in which an incident could occur.

The Hamersley Iron modelling conducted at the Australian Maritime College only considered a propulsion failure occurring 15 minutes out from the berth with tugs immediately at hand.

On 25 August, the first problems with the main generators occurred while *Hanjin Dampier* was in the outer reaches of the Hamersley Channel. Had there been tug assistance readily available, it certainly would have decreased the risk to the ship if the crew had elected to stop in the channel and make repairs, or if the ship had blacked out in the channel.

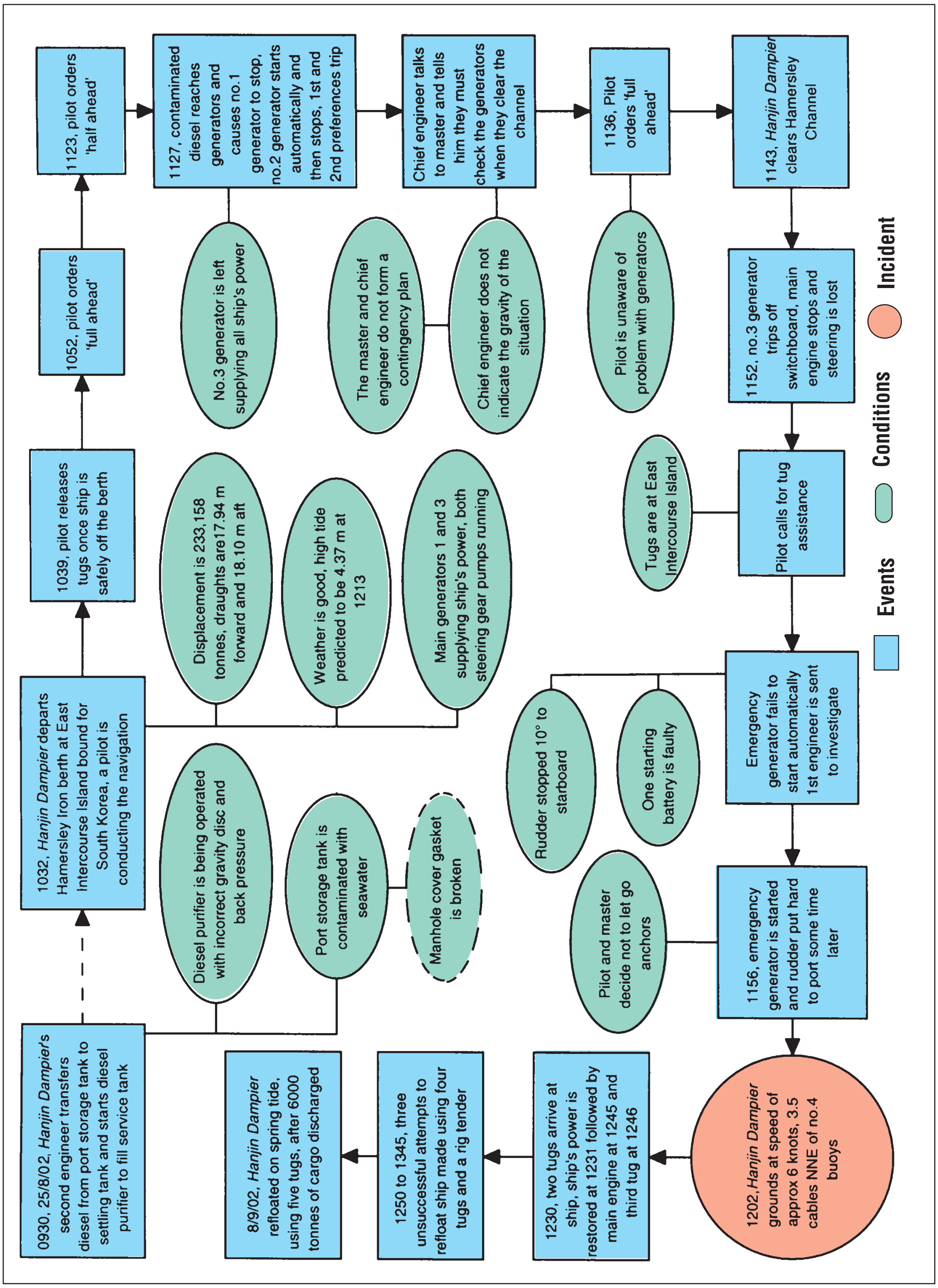
The *Pierre LD* grounding in 1992 also highlighted the issue of tug escorts for outbound deep draught iron ore ships. Like *Hanjin Dampier*, the tugs had been dismissed immediately after *Pierre LD* had unberthed leaving the ship to navigate the Hamersley Channel unescorted. When the blackout occurred the pilot requested immediate tug assistance but the tugs did not arrive in time to prevent the ship from grounding.

A ship grounding in the channel would effectively shut down the operation of both the East Intercourse Island and Parker Point facilities. In view of this, consideration should be given to increasing the time that tugs accompany ships in the channel.

In his submission the pilot stated:

> The question of escort tugs is a contentious one worldwide and the only comment I would make is that I believe their use with outbound vessels in Dampier would only make sense if they were used for the entire pilotage. I do not believe that the Hamersley Channel represents a greater risk to outbound deep draught ships than does the rest of the deepwater track to the sea buoy. Certainly in this instance if we had released an escort tug at the fairway beacon it would have been unlikely to get back to us in time to prevent the grounding.

FIGURE 3:
***Hanjin Dampier*: Events and causal factors chart**



Conclusions

These conclusions identify the different factors contributing to the incident and should not be read as apportioning blame or liability to any particular individual or organisation.

Based on the evidence available, the following factors are considered to have contributed to the grounding of *Hanjin Dampier* on 25 August 2002:

1. The ship grounded as a result of the loss of steering which lasted for a period of about 4 minutes between 1152 and 1156.
2. Steering was lost when the ship's three main generators tripped off the main switchboard due to water contamination of their fuel supply.
3. The diesel purifier was being operated in a manner which allowed the water contamination to be carried over into the diesel service tank.
4. The emergency generator failed to start automatically due to a fault in one of its starting batteries.
5. The requirements for periodically testing ship's emergency power systems are inconsistent with those stipulated for other safety equipment.
6. Lack of effective communication between the chief engineer and master meant that the bridge team were unaware of the risk to the ship after the first two generators had stopped and thus precluded the possibility that they could take pre-emptive action.
7. The crew took no action nor instigated any contingency plan in the time leading up to the blackout, when they could have reduced the risk to the ship.
8. There was a lack of any particular guidance for the crew in terms of the procedures in use on board.

Additionally but not directly

1. Tug escorts for the deeper draught vessels departing the port could provide additional safety assurance.

Recommendations

MR20030046

Ship owners/managers should review the procedures for, and frequency of, testing emergency power generation arrangements on their ships to ensure that this equipment has the highest possible reliability and availability.

MR20030047

Ship owners/managers should consider bridge resource management training for engineering officers.

MR20030048

Hamersley Iron should review the risks associated with the navigation of outbound deep draught ships, particularly in the Hamersley Channel, and consider extending tug escort times.

Submissions

Under sub-regulation 16(3) of the Navigation (Marine Casualty) Regulations, if a report, or part of a report, relates to a person's affairs to a material extent, the Inspector must, if it is reasonable to do so, give that person a copy of the report or the relevant part of the report. Sub-regulation 16(4) provides that such a person may provide written comments or information relating to the report.

A copy of the draft report was sent to the pilot, master, chief engineer, owners and managers of the ship, Hamersley Iron, Dampier Port Authority and the Australian Maritime Safety Authority.

Submissions were received from the pilot, owners, Dampier Port Authority, Hamersley Iron and the Australian Maritime Safety Authority. Submissions were included and/or the text of the report was amended where appropriate.

Hanjin Dampier

Name	*Hanjin Dampier*
IMO Number	8811144
Flag	Korea
Classification Society	Korean Register
Ship Type	Bulk Carrier
Builder	Hyundai Heavy Industries Company, Ulsan, Korea
Owners	Hanjin Shipping Company, Seoul, South Korea
Ship Managers	Hanjin Shipping Company, Seoul, South Korea.
Gross Tonnage	110 541
Net Tonnage	64 786
Deadweight (summer)	207 346 tonnes
Summer draught	18.02 m
Length overall	309.00 m
Breadth	50.00 m
Moulded depth	25.70 m
Engine	Hyundai B&W 6L80MCE, 6 cylinder, 2 stroke, single acting, direct reversing
Engine power	12 959 kW
Service speed	13.0 knots
Crew	22 Korean and Indonesian nationals

Independent investigation into the grounding of the Korean flag bulk carrier Hanjin Dampier at Dampier, Weatern Australia, 25 August 2002

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